American POTATO JOURNAL

Volume 30 *April 1953* *Number 4*

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Potato News and Reviews

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American Potato Journal

PUBLISHED BY
THE POTATO ASSOCIATION OF AMERICA
NEW BRUNSWICK, N. J.

Price $4.00 per year, in all countries

Entered as second class matter at New Brunswick, N. J., March 14, 1942 under Act of March 3, 1879. Accepted for mailing at special rate of postage provided for in section 412, Act of February 28, 1925, authorized on March 14, 1928.

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SPECTROPHOTOMETRIC COMPARISON OF INTERNAL BLACK SPOT AND MELANIN[1]

C. H. VANMIDDELEM[2,3], W. C. JACOB[2] AND H. C. THOMPSON[2,4]

The bluish-black discoloration known as internal black spot of potatoes has continuously been referred to in the literature as melanin or a "melanin-like" pigment. This study was undertaken to verify whether internal black spot was actually melanin or merely a pigmentation similar to after-cooking blackening. Melanin prepared from fresh potato juice was compared spectrophotometrically with extracted tuber sections having internal black spot discoloration.

Melanin is a substance that has received considerable attention in many varied fields and has been investigated for centuries. Despite a wealth of other information, the immediate precursors of melanin and its exact chemical structure remain unknown. The following properties have been used to characterize melanin: color, site of formation, state of aggregation, mechanism of production, nature of the chromogen, solubility, chemical reactivity and composition. Intimately combined colloidal masses surrounding the melanin molecule have prevented its isolation and the subsequent determination of the exact chemical structure of melanin.

Melanin has been found to be insoluble in water or organic reagents. It is moderately soluble in alcohol and pyridine and completely soluble in acids and alkali. In biological investigations, any black, brown, reddish-brown, tan or amber pigment is likely to be called melanin. Therefore, we may associate melanin as a non-specific name for a large group of heterogeneous pigments which absorb light in a similar manner.

Ginsberg (1) noted almost identical spectral absorption curves when black hair from a guinea pig and potato tuber melanin were compared spectrophotometrically, suggesting that both utilize the same biochemical pathway in melanin formation. He studied melanin prepared from different sources in the animal and plant kingdom (including potato tuber melanin) and concluded on the basis of the similarity of their spectral curves that there was no difference in their molecular structure.

It has been claimed by Mason (3) that synthetic melanins are obtained by the *in vitro* oxidation of benzenoid and phenolic amino acids. This oxidation may be photochemical, chemical, auto-oxidative or even enzymatic.

The color of melanin has been shown by Jacobsen (2) to depend on its quantity. Consequently, dense melanin granules appear black whereas sparse areas appear brown or tan. He found melanin to be readily removed from tissues with alkalies and to a lesser extent by acids. But, although the extracting solution becomes highly colored, it cannot always be assumed that all the extracted material is any longer simply melanin.

Later, Ginsberg (1) found that melanin derived from synthetic DOPA had the same spectral curve as that derived from synthetic tyrosine, potato tuber melanin and dissolved pigment from black pigs. Therefore,

[1]Accepted for publication January 8, 1953.

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this would seem quite compatible with the theory that DOPA, tyrosine and natural melanin pigment, wherever found in nature are one and the same entity and that the lighter and darker shades of melanin are merely quantitative differences.

Nutting (4) working on after-cooking blackening in potatoes, ran spectrophotometric determinations on melanin from after-cooking blackening as compared with melanin formed from raw potato juice. She summarized her work by claiming that the gray pigment from after-cooking darkening was not the same as the raw potato juice melanin, at least as far as their spectral curves showed.

Methods

Melanin was prepared from two different sources to compare with the melanin-like discoloration taken from tubers having black spot. It was first prepared from Long Island Green Mountain variety potatoes which had no discoloration. A 50-gram fresh weight sample of tuber slices ⅛ of an inch thick was taken from the stem end and placed in a Waring blender for 5 minutes.

The homogenate was then filtered through a double thickness of cheesecloth. The starch was allowed to settle for one-half hour at room temperature. Then the red supernatant liquid was decanted off and placed in cold storage for two days. At the end of that time, the solution had darkened considerably and more starch had settled out. The supernatant was again decanted and takadiastase was added to digest any excess starch in the solution. The mixture was allowed to stand overnight with the melanin precipitating out. Takadiastase was again added to remove the starch granules that might have embedded themselves in the melanin.

This deposit of impure melanin was washed several times with distilled water, dilute hydrochloric acid, distilled water repeated, absolute alcohol, dilute alcohol and again distilled water. The melanin was then dried over sulfuric acid in a vacuum desiccator.

The second preparation of melanin used to compare with internal black spot discoloration was prepared artificially through the use of the tyrosine-tyrosinase reaction. In the course of the usual separation procedure, protein impurities contaminated the melanin formed by the above reaction. To prevent this protein contamination, the tyrosine-tyrosinase reaction was accelerated by the use of a potassium acid phthalate buffer at pH 6.5. Later in the experiment, the McIlvaine buffer series was substituted for the phthalate buffer.

To 20 ml. of a saturated tyrosine solution there were added 2 ml. of freshly prepared and buffered potato juice. This mixture was placed in a 37-degree C. oven overnight. The melanin formed in this manner was separated from the extraneous colloidal material exactly as described in the first melanin preparation. Likewise, the melanin-like darkened areas known as internal black spot were carefully cut from the tubers and extracted and treated as mentioned above.

The dried purified melanin from the above three sources was weighed accurately. Solutions of known concentrations were prepared in .05 normal sodium hydroxide and read with a Beckman DU spectrophotometer, using the hydrogen discharge lamp as a source of ultraviolet light. Readings

were taken at each 10 mu interval in the ultraviolet range from 220-320 mu. At 320 mu the visible lamp was attached and the readings from 320 to 400 mu were accomplished. If a peak was suspected, closer readings were taken in an endeavor to determine more clearly where the curves developed.

Results

Figure 1 shows the results of spectrophotometric analysis completed on three types of melanin preparation. Curve "O" is reported by Nutting (4) as produced by after-cooking blackening in boiled potatoes. Curves "4" and "5" are also taken from the work of Nutting (4) which she describes as being melanin prepared from raw potato juice only and raw potato juice plus tyrosine respectively.

Curves "1," "2" and "3" were plotted from the authors' readings and are designated as follows:

Curve "1" Raw potato juice
Curve "2" Raw potato juice + tyrosine
Curve "3" Pigmented areas from black spot potatoes

By following this procedure, it was thought that a fair comparison was made between two naturally forming melanins and the abnormal pigmentation of black spot potatoes. Since black spot is often confused with after-cooking discoloration, the curves for the two pigmentations are compared in figure 1. It can be noted that Curve "3", for a purified melanin preparation extracted from tubers affected with black spot discoloration, is very similar to those curves representing melanin from raw potato juice alone and from raw potato juice plus tyrosine except for small differences in the extinction coefficient. Figure 1 also emphasizes the basic differences in the curve representing black spot pigmentation and after-cooking blackening.

Discussion

In this study, it was attempted to prove that the black spot discoloration of potatoes is actually melanin. The close similarity spectrophotometrically between the three types of melanin including black spot extractions would indicate that they are of similar make-up. Of course, it is understood, despite exhaustive purification steps to get free melanin, extraneous materials are still present in the final product.

Summary

Spectrophotometric determinations on three different potato melanin preparations were compared. Results of these analyses would indicate that the two melanins, one obtained from fresh raw potato juice only and one from potato juice plus tyrosine, are closely related to the pigment extracted from the discolored areas of the raw potato affected with black spot. It may be concluded, therefore, that black spot pigmentation is some type of melanin and is not closely related to after-cooking blackening of potato tubers.

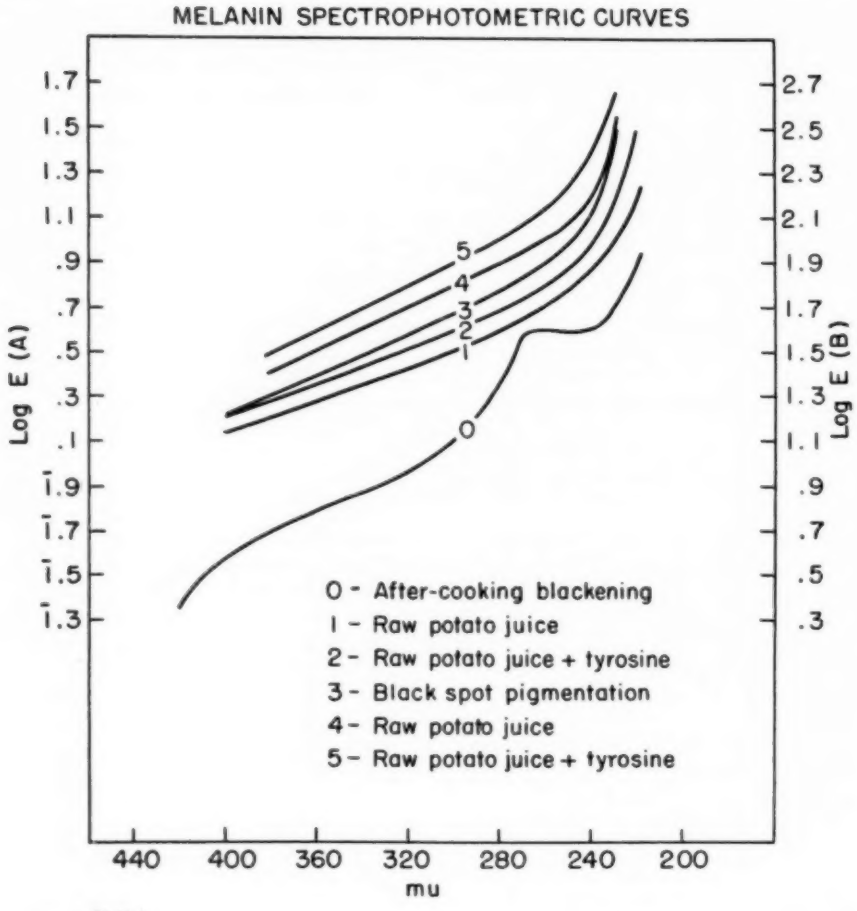

FIG.1

Figure 1.—Beckman Spectrophotometric curves in the Ultra Violet and Visible Wavelengths of Three Melanin Preparations: (1) Melanin prepared from raw potato juice; (2) Melanin prepared from raw potato juice plus tyrosine; (3) Melanin prepared from extracted Black Spot pigmentation.

Curves (4) and (5) are melanin preparations taken from the data presented by Nutting (4).

Curve (O) was also taken from Nutting's data for purposes of comparison.

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A METHOD OF OBTAINING FRUITS IN THE POTATO VARIETY RUSSET BURBANK[1]

CECIL F. PATTERSON[2]

INTRODUCTION

Since difficulty in inducing plants of the Russet Burbank potato to set fruits and produce seed has been experienced by others, the author decided to describe briefly a method that has given satisfactory results in the Department of Horticulture, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. This method was used in the Department for the first time in the year 1944. Each year since that time the method has been employed successfully. McLean and Stevenson (1) recently published an outline of the method used successfully by them in 1950 and 1951, which differs markedly from the one herein described.

Prior to 1944, numerous attempts had been made in this Department to obtain fruits from plants of the variety, Russet Burbank. Pollen of several varieties, among which were some producing highly fertile pollen, had been used. In some cases large numbers of flowers were worked. All such attempts were made with plants growing in the field. Without exception, every attempt failed.

TECHNIQUE USED

As a result of the repeated failures with plants growing in the open it was decided to try making the crosses indoors during the winter and early in the spring. Plans were made to provide a length of day similar to that provided by nature during the summer but to provide temperatures lower than those obtaining outdoors during the summer months.

Tubers that had been conditioned ("warmed up") were planted in eight-inch flower pots, one medium-size tuber in a pot, late in January. Ordinary greenhouse potting soil was employed. The tubers planted were covered with two and one-half inches of soil. The pots were placed on greenhouse benches of standard height. Growing temperatures of 68° — 70° F were provided the plants during the early stages of growth.

After the shoots began to appear the daylight was supplemented with artificial light. Two-hundred watt bulbs, placed approximately three feet above the tops of the pots, supplied the supplementary lighting. These were turned on at 11:00 p.m. and remained on until daylight the following morning. This made a total period of illumination of 18 to 19 hours, approximately, which was similar to that provided by nature during the month of July. The lights used were adjustable as to height and as the plants grew the lights were raised to avoid the undue heating of the tips of the shoots.

As soon as flower-buds were visible, the plants bearing buds were transferred to a compartment of the greenhouse where lower temperatures could be provided. From that time forward the plants were grown at temperatures between 50° and 60° F., except on occasional warm sunny days when higher temperatures around mid-day were unavoidable. The periods during which the plants were exposed to higher temperatures were of short duration, however.

[1]Accepted for publication February 2, 1953.

[2]Professor of Horticulture and Head, Department of Horticulture, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Standard procedure was followed in the technique of crossing. Emasculation was carried out in the well developed bud stage. The aim was to emasculate the buds about one day before they were due to open. The pollen was applied to the stigmas immediately after the buds were emasculated. The pollen was usually applied by means of the thickened base of the tweezers used for emasculation. This base of the tweezers was brought in contact with the pollen in the pollen-dish and was then brought gently in contact with the stigma. Each stigma was well coated with pollen as could be easily seen with the naked eye. Sufficient pollen usually adheres to the base of the tweezers from one dipping, to cover two or three stigmas or more. All the pollinated flowers were left uncovered.

The pollen used was usually from one to three days old counting from the time the anthers were removed. Pollen grains up to seven days old have been used successfully, however, when merely a warm room was used as a storage. The anthers to supply the necessary pollen were removed from buds that were about to open and were placed shallowly in small petri dishes. The dishes were then kept in a warm room, at a temperature near 75° F., with the covers of the dishes removed. The pollen was usually available for use twenty-four hours after the anthers had been taken.

Results

The results far exceeded expectations. From relatively few flowers of plants of Russet Burbank handled in this way, several fruits were harvested. These fruits were of good size and each fruit possessed a goodly number of plump seeds. An excellent germination of the seed harvested was obtained and approximately 125 selections were made the following year from the population of seedlings grown from the combination, Russet Burbank x Earlaine, made in 1944. Other varieties used as female parents in 1944 responded well to this treatment and large harvests of fruits were obtained.

Since that time all the potato plants used for breeding purposes in this Department have been grown indoors and have been treated in a manner similar to that outlined above. The results obtained over the period of years since 1944 have been very satisfactory. Clusters with as high as a dozen fruits, each with a goodly number of seeds, have been harvested. Certain varieties, other than Russet Burbank, that are averse to the setting of fruits when the plants are grown outdoors, have responded favorably to this treatment.

Discussion

Although unable to contribute much under this heading, the author is firmly of the opinion that high temperatures, in some way, speed up the abscission process in flowers of certain varieties of the potato. This opinion is based on observations made on plants growing indoors. Grown at temperatures above 65°F., plants of Russet Burbank and of certain other varieties usually drop their buds before bud-opening takes place. In some cases abscission takes place while the buds are very small and several days before normal opening would take place. Keeping temperatures below 60°F. permits the buds to develop fully and to open in a normal

manner. When fertilization is accomplished under these conditions normal fruits are likely to be harvested.

The contention of McLean and Stevenson (1) that the production of seed balls in Russet Burbank appears to be correlated with the non-movement of carbohydrates from the top of the plant to the part below ground is not supported by the observations of the author. Concomitant with the production of seed balls, in plants of Russet Burbank growing in pots at temperatures between 50°F. and 60°F., has been the development of substantial tubers below ground. This is true in certain other varieties also. Tubers produced by such fruiting plants have been equal in size to tubers produced by plants grown at higher temperatures and by plants which failed to set fruits.

The failure of the abscission layer to develop at the lower temperatures may be associated with a greater production or a greater retention of a growth hormone at such temperatures that does not favor the formation of an abscission layer in the pedicel. Or the materials that initiate the formation of the abscission layer may not be manufactured at the lower temperatures in the amounts necessary to effect abscission.

Another possibility in attempting to account for the behaviour of the plant being grown at the lower temperature is in the nitrogen level of its tissues. The tissues of plants growing at the lower temperatures probably have a higher nitrogen level than the tissues of plants growing at higher temperatures. At the lower temperatures the plant is making slower growth with the consequent lower demand for nitrogen. This would tend to result in a higher nitrogen level in the tissues of the plant. Raising the nitrogen level in the tissues of the plant through the application to the soil of fertilizers high in nitrogen, a short time before the flower buds open, is a common method of increasing the set of fruits in orchard practice. It is not unlikely that an increase in the nitrogen level in the plant during the period following bud formation, if not excessive, would have a similar effect on the fruit-set in the potato. This remains to be investigated.

Summary

1. A simple method of inducing plants of Russet Burbank and plants of certain other varieties that usually fail to set fruits in the field is outlined.
2. An 18-hour day throughout the growing period and growing temperatures of 50°—60° F. after the buds form, favor the setting of fruits and the production of seed in such varieties.
3. This method was first used by the Department of Horticulture, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, in 1944 and has been used successfully each year since that time.

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1. McLean, John G. and F. J. Stevenson. 1952 Methods of obtaining seed on Russet Burbank and similar -flowering varieties of potatoes. Amer. Potato Jour. 29:206-211.

VARIETAL SUSCEPTIBILITY TO INTERNAL BROWN SPOT OF POTATOES[1]

J. Howard Ellison[2]

Larson and Albert (2, 3) reported that under hot dry weather conditions in central Wisconsin, internal browning of potato tubers was a common defect, and there was considerable variation among varieties. Ellison and Jacob (1) also noted that the Green Mountain variety showed more brown spot than Katahdin when grown on Long Island under different dates of planting and various other cultural practices. Because of the importance of this defect and its large variation among different varieties, incidence of browning is regularly considered in the testing of new potato varieties for adaptability to Long Island conditions.

[1]Accepted for publication March 3, 1953. Paper number 365, Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

[2]Assistant Professor of Vegetable Crops, Cornell University, Long Island Vegetable Research Farm, Riverhead, N. Y.

Materials and Methods

This report concerns four years' data on brown spot collected from the regular potato variety trial at the Long Island Vegetable Research Farm. From 1948 through 1950, samples of 20 tubers each were taken from all field replications and placed in common storage immediately after harvest. The samples were removed from storage during the first week of February each year and examined for internal browning. The tubers were sliced into quarters longitudinally and all eight sufaces were examined carefully. All brown spot lesions were considered, even though some were so small that they would not have been picked up in a routine government inspection. The procedure was the same in 1951, except that the samples consisted of 50 tubers each.

Results and Discussion

The list of varieties changed considerably from year to year, since undesirable ones were dropped and new ones were added. The selection of varieties for testing was based on their general performance, so that some varieties were discarded even though they had low brown spot readings.

Incidence of internal browning associated with the potato varieties is given in table 1. Legitimate comparisons can be made only among varieties which were tested the same year or years, because of diverse seasonal variations. It was unfortunate to have some varieties represented all four years and others only one; nevertheless, all available data were presented, because one year's results were significant in certain cases. For example, B637-14 would be discarded after one year's testing because of a reading of 54 per cent brown spot. Obviously a low reading from only one year's test is not necessarily significant, since further testing would be needed to establish definite brown spot resistance.

Most of the varieties fell into three general groups; namely: 1. those which were consistently resistant to internal browning; 2. those which

TABLE 1.—*Percentage of internal brown spot associated with potato varieties from 1948 through 1951.*

Potato Varieties	Mean Brown Spot Per cent			
	1948	1949	1950	1951
La Sota	—	0	—	—
Progress	—	—	1	—
Norkota	2	—	—	—
Virgil	2	—	—	—
Pontiac	6	0	0	—
Canoga	—	—	1	4
Chippewa	1	5	—	—
Katahdin	1	12	2	0
Kasota	—	—	4	—
Houma	0	8	—	4
Placid	1	—	—	8
Kennebec	5	0	8	7
Keswick	—	—	—	5
Canso	—	—	—	5
Mohawk	2	12	1	—
Snowdrift	10	2	—	—
Cobbler	5	15	4	3
Pungo	—	—	—	7
Cherokee	—	13	—	2
Chenango	8	—	—	—
Canus	—	—	8	—
Ontario	18	0	11	6
Teton	8	10	9	—
Warba	—	10	—	—
Essex	2	42	4	2
3175	—	13	—	—
Green Mountain	6	27	8	12
Harford	14	—	—	—
Sequoia	15	—	—	—
B73-10	—	—	—	15
Erie	16	15	—	—
LaSalle	—	28	4	—
Sebago	4	42	25	13
Madison	—	33	14	—
Yampa	—	—	25	—
Ashworth	26	42	24	—
B637-14	—	—	—	54
L.S.D. .05	11	7	3	9

were consistently susceptible; and 3, those which varied greatly from year to year. The first group is represented by Pontiac, Kennebec, Katahdin and Mohawk, which were relatively resistant each year they were tested. Group two is best represented by Ashworth, which was consistently highly susceptible. The third group includes Essex, Sebago and Ontario, which varied respectively from 2 to 42, 4 to 42 and zero to 18 per cent brown spot from year to year. This great seasonal variation exhibited by certain varieties emphasizes the importance of testing new varieties for several years before drawing any conclusions.

SUMMARY

Incidence of internal brown spot associated with various potato varieties grown on Long Island from one to four years was reported. Some varieties, such as Pontiac, Kennebec, Katahdin and Mohawk, were relatively resistant to brown spot each year. Ashworth was quite consistently susceptible. Other varieties, such as Essex, Sebago and Ontario, fluctuated considerably from year to year.

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CERCOSPORA LEAF SPOT AND STEM CANKER DISEASE OF POTATO[1]

M. J. THIRUMALACHAR[2]

A leaf spot and stem canker disease of potato incited by a species of *Cercospora* has been found to be of widespread occurrence in Bihar and Uttar Pradesh in India. The disease symptoms are quite distinct from those of *Cercospora concors* (Casp.) Sacc. which usually occur on potato leaves in crops grown on the hills. An epiphytotic of the disease occurred in Patna, Bihar, during the crop season of 1951-1952 which warranted a detailed study of the etiology of the fungus with a view to devising control measures.

The disease appears on the crop during the latter part of December (planting being done during 2nd week of October). The older leaves near the ground first show infection spots which are circular to polygonal, 2 to 5 mm. in diameter, yellowish-brown and often coalesce to form large patches. On some of the susceptible varieties like O.N.208 and Hyb.19, large spots with concentric zonations of growth are produced and these may be mistaken for infection spots of *Alternaria solani* (E.&M.) Jones and Grout. After drying, leaf spots, which are the fruiting bodies of the fungus, are profusely developed.

Stem infections are not observed on the plants until about the first week of January. Lesions then appear on stems and petioles as linear elongated to lenticular patches (Fig. 1). These in later stages extend from 2 to 4 cms. in length, becoming black and bearing the fruiting

[1]Accepted for publication Feb. 9, 1953.
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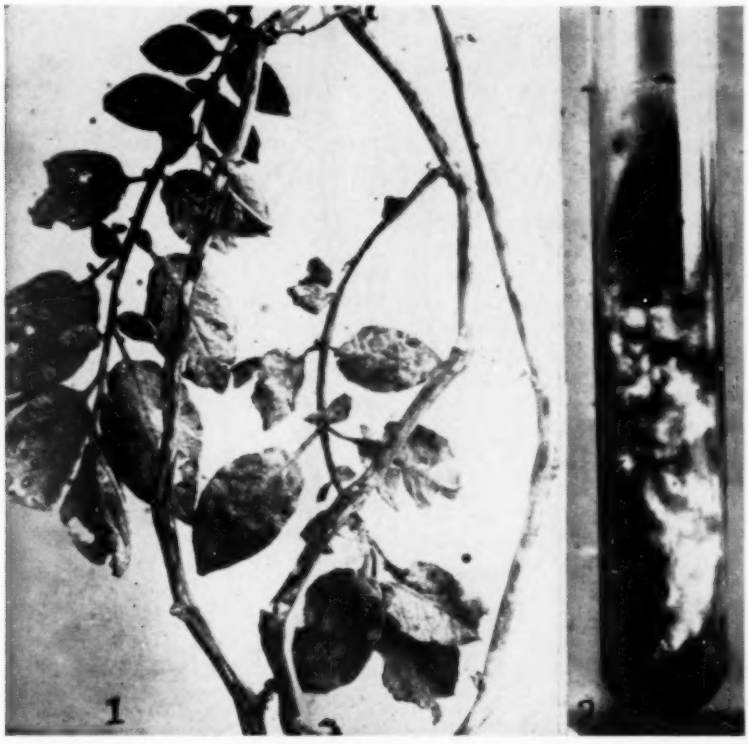

Fig. 1.—Showing the leaf spotting and lesions on stems.
Fig. 2. Growth of the fungus in artificial culture.

structures of the fungus. The cortex or stem tissue first becomes necrotic and in most of the affected plants the stems lie prostrate and get injured during heavy winds. The infected plants show premature drying in fields presenting the appearance of a crop affected by severe drought.

A microscopic examination of the infected spots revealed intercellular septate hyphae of the fungus which emerges through the stomata with a small compact stromata composed of a thick-walled hyphae. From these stromata, numerous septate conidiophores arise which are yellowish-brown, unbranched, 2-3-septate at base, geniculate and paler in color at the top (Fig. 3). Mature conidia are obclavate to cylindric, hyaline, straight, 1-12 septate, obtruncate at base and acute at apex, and measure 41-120 x 2-3.5 u (Fig. 4). Comparative studies indicate that the fungus represents an undescribed species. *Cercospora solanicola* Atk. recorded from Alabama, U.S.A. also incites small brownish spots with whitish centers on the leaves, but the conidia are very large in size being 30-septate, and measuring 100-230 microns in length. *C. concors* which occurs on the hills in India incites pale violet fuzzy growth on leaves with creeping hyphae and possessing subhyaline conidia measuring 15-90 x 4-6 u. *C. heterosperma*

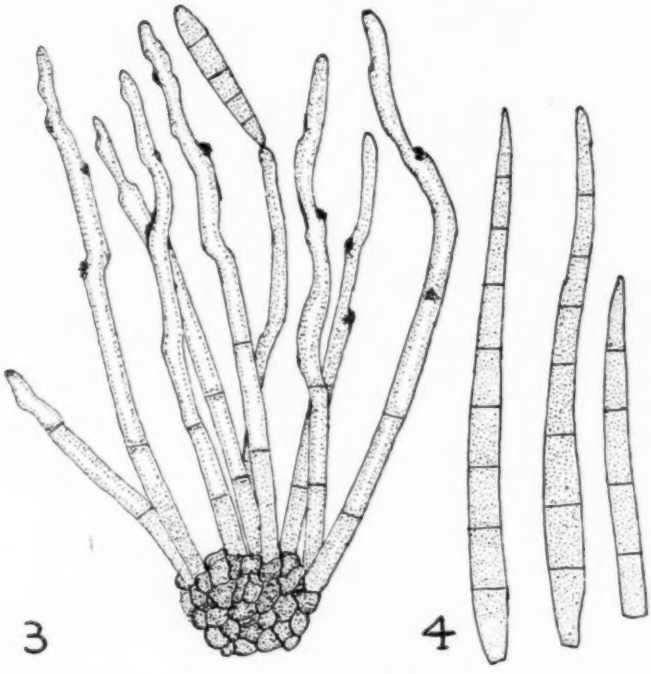

Fig. 3.—Fruiting structure of fungus x 1000.
Fig. 4.—Conidia x 1000.

Bres. recorded on potato leaves from Poland may be closely related to or identical with *C. concors* but has no relationship with the fungus under study.

Cercospora solani-tuberosi Thirumalachar *sp. nov.*

Infection spots on leaves reddish-brown, circular to polygonal, 2 to 5 mm. in diameter, often coalescing; on stems elongated to lenticular spots, 2 to 4 cms. long later turning black. Fruiting bodies amphigenous, stromata compact, small, 35 u. in diameter. Conidiophores yellowish-brown, 2-3-septate at base, unbranched, geniculate, paler towards the apex 30-110 x 3.4 u.; conidia obclavate to cylindric, 1-12-septate, hyaline, obtruncate at base, acute at apex, 41-120 x 3.35 u.

Habitat: On leaves and stems of *Solanum tuberosum* L., Patna, Bihar, 20-12-1952 (Type). Type deposited in Herb. Crypt. Ind. Orient. New Delhi.

Maculae foliorum circulares ad polygonales 2-5 mm. in diam. rubro-brunneae, coalescentes. Fructification amphigena, stromate constantis ex cellulis compacte aggregatis, 35 u. diam. Conidiophori luleto-brunnei vel pallide, 2-3-septati, pahud ramosi, geniculati; 30-110 x 3-4 u. Conidia obclavata vel cylindrica, hyalina, recta, 1-12-septata, obtruocata ad basim, acuta apicem, 41-120 x 3-3.5 u.

Artificial Culture and Inoculation Experiments.

The fungus was readily isolated by transferring aseptically germinating conidia on potato dextrose agar. The colonies grow slowly, are white at first and gradually turn olive-grey, with whitish fluffy hyphae intermixed (Fig. 2). The submerged hyphae are thick-walled, and yellowish-brown in color. No conidial formation has been observed in old cultures, but in the young colony developing from germinating conidia few acicular conidia are formed.

Inoculation studies were carried out using conidia produced naturally on hosts as well as fragments of hyphae from artificial cultures. Plants of O.N. 208 potato variety were used for inoculations. The plants were inoculated after spraying with water and enclosed in moist chambers for 24 hours. Successful inoculations with conidia produced naturally on the host were obtained in 15 out of 25 inoculated leaves, after 15 days, whereas with hyphal fragments from artificial cultures only 3 out of 25 cases gave positive results. None of the controls showed disease symptoms.

Oversummering of the Fungus.

Studies were made on oversummering of *C. solani-tuberosi* in relation to its annual recurrence. Dried stems bearing large infection cankers were placed in the field after the harvest and examined periodically for the presence of visible spores *etc.* Observations showed that after April, the conidiophores broke down leaving behind the stromata composed of few thick-walled cells. These soon became conspicuous by developing few more cells and forming a tiny sclerotial body. When scraped and examined under the microscope, one may be mistaken for those of *Macrophomina phaseoli* (Maub.) Ashby. But the presence of the remnants of conidiophores is the determining factor. Observations made during July, soon after the beginning of a rainy season showed that the conidiophores had started to develop from the broken ends and to abstrict numerous acicular conidia. This conidial production continues until the end of October, when the planting season for potato crop in the plains commences. These conidia, when cultured on potato dextrose agar, gave the same type of growth as was noted before. The fungus therefore oversummers on debris material by the formation of sclerotial bodies which are the transformed stromata.

Control.

Even though the fungus oversummers on infected debris, the disease becomes severe in the field by the end of December or January. Young vigorously growing plants do not show much infection. Apart from the destruction of debris material, conditions favorable for vigorous vegetative growth of plants such as an application of heavy nitrogenous manure, and good irrigation should be given. Under conditions prevailing in Bihar, a prophylactic spray of Bordeaux 5:5:50, or Perenox (0.3 per cent) or Dithane Z-78 (1½ pounds in 100 gallons of water) has given good results. The fungicides are usually applied for controlling the late blight and early blight diseases in the seed-producing areas of Patna, Bihar. One or two sprays at an interval of 14 days after the 20th of December has protected the plants against stem lesions and leaf spotting and kept them green for a longer period than the controls.

In conclusion the writer wishes to acknowledge his indebtedness to Dr. S. Ramanujam for the benefit of valuable suggestions and encouragement.

POTATO NEWS AND REVIEWS

POTATO TUBER DEVELOPMENT I. THE RUSSET BURBANK VARIETY; INFLUENCE OF SEED-PIECE ORIGIN AND SPACING ON TUBER SIZE AND SHAPE[1]

G. H. Rieman, D. C. Cooper and Melvin Rominsky[2]

Introduction

The Russet Burbank variety of potatoes has been grown extensively in the Western Rocky Mountain and Pacific Coast states for many years. The largest acreages have been grown in Idaho where the variety is also called Netted Gem or Idaho Russet. It is recognized as one of the best potato varieties from the standpoint of table quality. For this reason numerous attempts have been made to grow commercial acreages of Russet Burbank in other parts of the country during the past three or four decades. These attempts to grow this variety in the potato production areas of the Middle Western, Southern and Eastern states have, until recently, met with failure or with very limited success.

[1]Accepted for publication April 1, 1953.
Contribution from the Wisconsin Agricultural Experiment Station. Paper No. 514 from the Department of Genetics.

[2]Professor of Horticulture and Professor of Genetics, respectively, University of Wisconsin, Madison, Wis. and Seedsman, Starks Farms, Inc., Rhinelander, Wis. The authors are indebted to Eugene Herrling for assistance with the illustrations.

Significant changes in agricultural practices during the past decade have been responsible for outstanding increases in the growing of Russet Burbank potatoes in Wisconsin from only a few acres in 1940 to more than 5000 acres in 1952. The variety presents three major difficulties when grown in Wisconsin, namely; (1) it usually sets a large number of tubers per hill resulting in the production of high percentages of undersized potatoes which sell at a discount on the table stock market; (2) it frequently produces discouragingly large numbers of knobby tubers in comparison with other standard varieties; and (3) it requires a constant and ample moisture supply to produce a satisfactory crop. Sufficient moisture usually occurs naturally in muck soil but must be added most seasons on upland soils by means of supplemental irrigation. Adequate solutions for the first two problems have not been found. The third problem has been fairly well solved with the introduction and use of modern irrigation equipment and methods. Over 200 portable irrigation rigs capable of furnishing supplemental moisture in ample quantities to 20,000 acres are now available in the state.

Various methods have been tried during the past ten years to reduce the volume of undersize and knobby potatoes in Russet Burbank crops. It has been noted that this variety frequently develops more stems per hill when compared with standard varieties such as Katahdin and Red Pontiac. It has also been observed that uneven stands and hills with only one stem are responsible for high percentages of large knobby tubers ten ounces or more in size. Similar observations have been made by workers in Idaho. The influence of potato seed-pieces 1½ ounces in weight obtained from various tuber sizes have been tested for several seasons, in preliminary field trials. Our most uniform stands were however, obtained following the

planting of whole B size tubers, whereas the most uneven stands were obtained from planting seed-pieces cut from large tubers weighing 10 ounces or more. The potatoes produced from the whole B size seed were considerably smaller and smoother than the potatoes produced from seed-pieces of equal weight cut from the larger tubers. However, the total crop yields from the two types of seed were approximately the same.

Materials and Methods

A more detailed field experiment was made to determine the effect of 5 seed-piece treatments and 5 spacing treatments on tuber size and shape. Seed-pieces 1½ ounces in weight were prepared from the following seed stock sources:

1. Large (Jumbo) seed tubers weighing more than 10 ounces.
2. Medium seed tubers 1⅞ inches in diameter to 10 ounces in weight.
3. Medium seed tubers 1⅞ inches in diameter to 10 ounces in weight with ¾ inch of the apical end removed.
4. Small (B size) seed tubers 1½ inches to 1⅞ inches in diameter with ¾ inch of the apical end removed.
5. Small whole (B size) seed tubers 1½ inches to 1⅞ inches in diameter.

The 5 seed stocks were planted in double rows 3 feet apart with the standard spacing distance of one foot between seed-pieces. Regular certified seed (1⅞ inches in diameter to 10 ounces in weight) was used to prepare 1½ ounce seed-pieces for the following spacing treatments: (1) 12 inches (2) 18 inches (3) 21 inches (4) 24 inches and (5) 30 inches. These planting distances between seed-pieces were used in double rows three feet apart. Each treatment was replicated four times in double-row plots 75 feet long. Standard cultural practices were used. The over-all plot yield was in excess of 500 bushels per acre. The crop from each plot was graded and weights were recorded for the following classes: (See Figure 1).

A—US1 Jumbo size — 10 ounces or larger
B—US1 size A — over 1⅞ inches in diameter with 40 per cent or more 6 ounces or larger
C—US1 size B — 1½ inches to 1⅞ inches in diameter
D—Knobs — shape too rough for US1 grade.

Results

The results (Charts 1, 2) indicate: (a) The 21-inch spacing produced the largest yield of US1 size A and Jumbo potatoes in the spacing trials. The superiority of the 21-inch spacing was closely followed by the performance of the 18-inch and 24-inch treatments. (b) There was a gradual but consistent increase in the volume of knobby tubers (15 bushels to 91 bushels) as the spacing distance was increased from 12 to 30 inches. This relationship was partially equalized from the standpoint of US1 size A and Jumbo production by a gradual but consistent decrease in the volume of the small US1 size B potatoes as the spacing distance was increased. (c) Seed-pieces cut from tubers 1⅞ inches to 10 ounces produced the largest yield of US1 size A and Jumbo potatoes in the seed

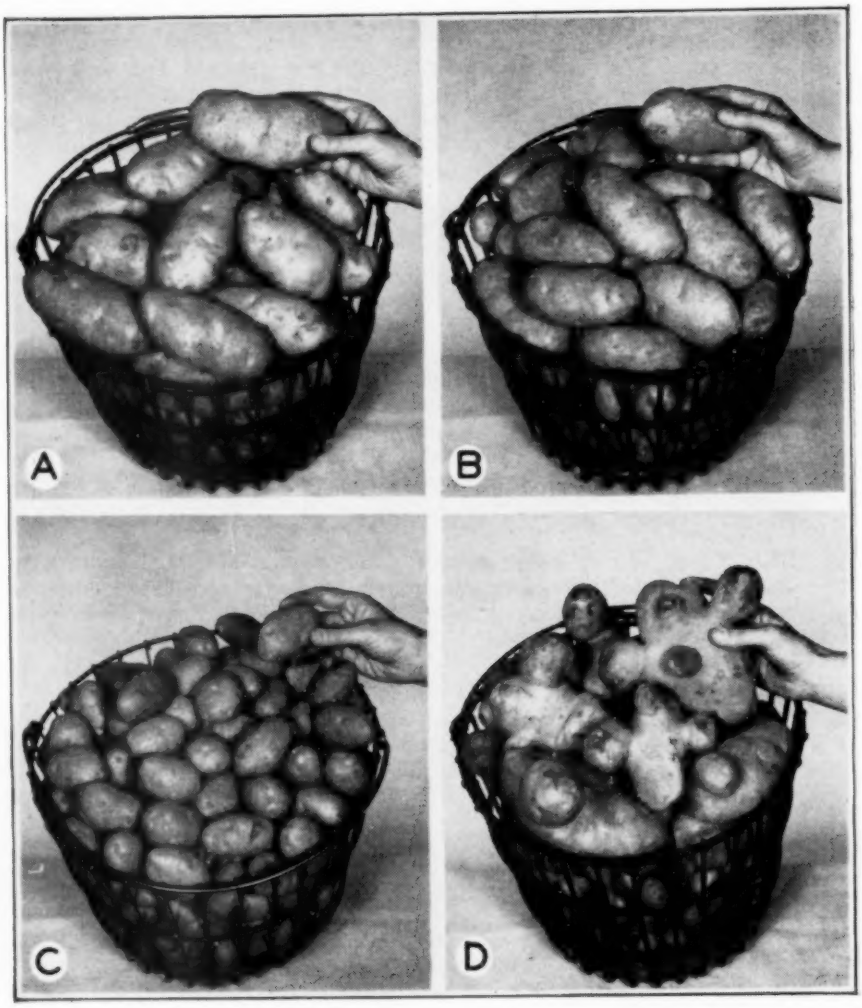

FIGURE 1.—Classes used in grading Russet Burbank potatoes in a field experiment designed to determine the effect of seed-piece spacing and seed-piece origin on tuber size and shape. A) US1 Jumbo size 10 ounces or larger. B) US1 size A, over 1⅞ inches with 40 per cent or more 6 ounces or larger. C) US1 size B, 1½ inches to 1⅞ inches in diameter. D) Knobs, shape too rough for US1 grade.

treatment experiments. Seed-pieces cut from large (Jumbo) tubers over 10 ounces in weight produced the largest yield of Jumbo potatoes. (d) The removal of ¾ of an inch of the apical end of seed potatoes failed to produce beneficial effects.

A detailed study was made of tubers produced from single hills grown from standard cut seed-pieces at a spacing of 24 inches in rows 36 inches apart. Approximately 200 hills were harvested by hand from a

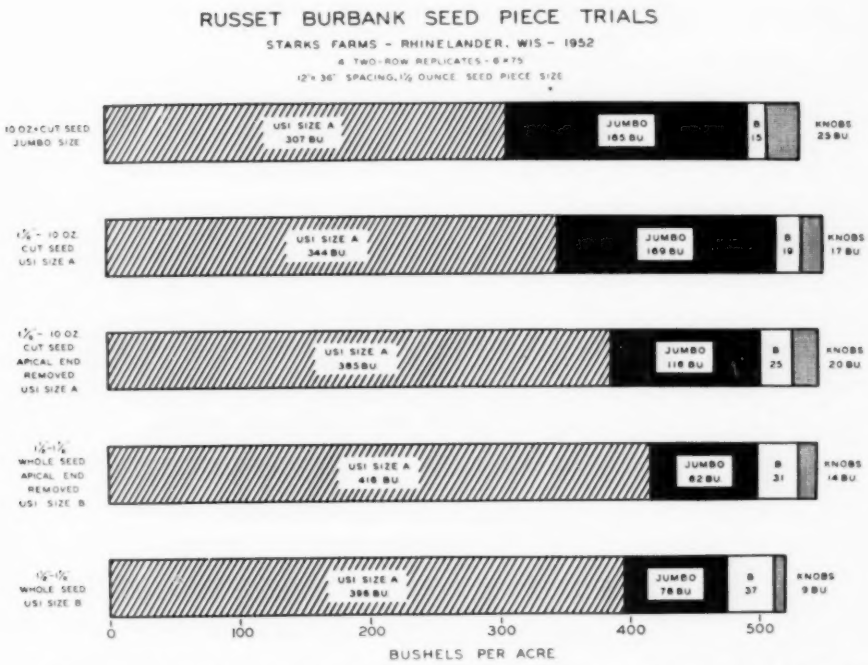

CHART 1.—Yields of four grades of Russet Burbank potatoes obtained from plantings of seed-pieces cut from large (Jumbo size), medium (US1 size A) and small (US1 size B) tubers and from plantings of small whole tubers.

portion of the field where the yield was in excess of 500 bushels per acre.

The results (Table 1, 2) indicate: (a) Nearly all hills with one stem produced knobby tubers, whereas hills with three or more stems produced only a few knobby tubers. (b) Tuber size decreased and the number of tubers increased at a fairly constant rate as the number of stems per hill increased from one to six. (c) Three stems per hill produced the highest yield of US1 potatoes over six ounces in weight.

The superiority of 3-stem hills was closely followed by the performance of the 2-stem and 4-stem hills. The 1-stem, 5-stem, and 6-stem hills were decidedly inferior in the production of US1 potatoes over six ounces in weight.

PRACTICAL APPLICATIONS

1. The standard practice of planting Russet Burbank seed-pieces at a spacing of 12 inches in the row for table stock production in Wisconsin may be improved by increasing the spacing distance to 18 inches or 21 inches in rows 3 feet apart.

2. Russet Burbank hills with three stems produce the highest percentage of US1 potatoes over 6 ounces in weight. Hills with one stem produce knobby potatoes. Hills with five or more stems tend to produce many small B size potatoes.

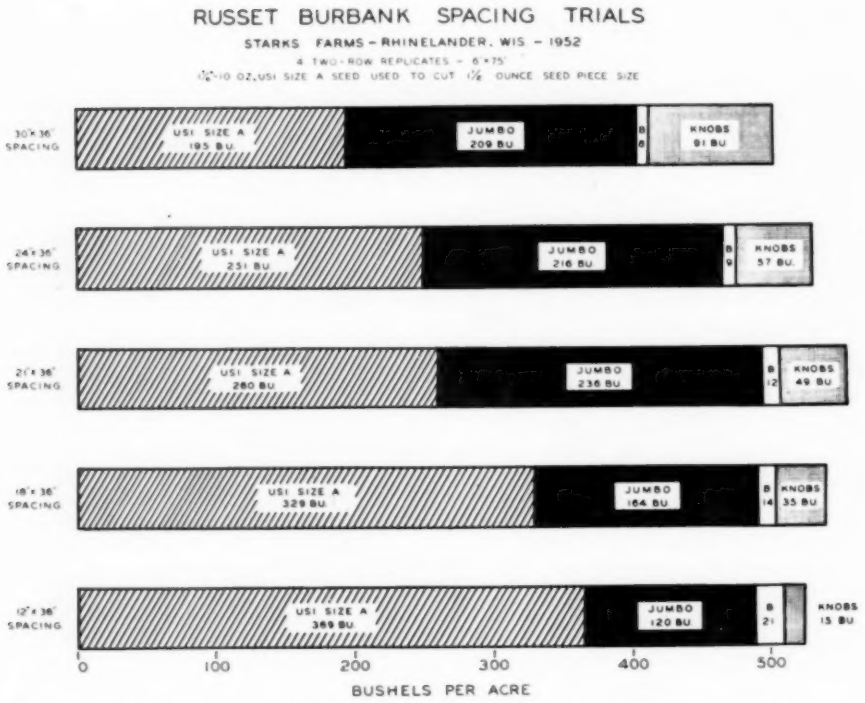

CHART 2.—Yields of four grades of Russet Burbank potatoes obtained from plantings of seed-pieces spaced 12, 18, 21, 24 and 30 inches in rows 36 inches apart.

TABLE 1.—*Size and shape of Russet Burbank potatoes produced from hills ranging in stem number from one to six.*

No. of Stems per Hill	No of Hills	Distribution of Crop Per cent			Average No. of Tubers per Hill
		US1 under 6 Ounces	US1 over 6 Ounces	Knobby Tubers	
1	7	15	48	37	9
2	33	23	64	13	11
3	50	30	65	5	12
4	42	40	57	3	14
5	17	50	49	1	18
6	3	68	32	0	19

TABLE 2.—*Shape of Russet Burbank potatoes produced from 1-stem and 3-stem hills which occurred in pairs.*

No. of Stems per Hill	No. of Hills with Smooth Tubers	No. of Hills with Knobby Tubers
1	4	17
3	19	2

3. Seed-piece spacing of 30 inches or more in the row or "skips" in the row because of uneven planting or poor seed, tends to increase the growth of knobby tubers of the large Jumbo size.

4. Small whole B size seed tubers tend to form hills with five or more stems resulting in the production of many undersized tubers when planted at a spacing of 12 inches in the row. Wider spacing for whole B size seed is suggested.

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1. Kraus, James E. 1945. Influence of certain factors on second growth on Russet Burbank potatoes. Amer. Potato Jour. 22:134-142.

AN ECONOMIC STUDY OF RETAIL MARKETING OF POTATOES GRADED BY SPECIFIC GRAVITY[1]

(Abs.)

The purpose of this research project was to ascertain consumer acceptance in a large industrial city of potatoes separated into various degrees of mealiness; to determine whether and to what extent consumers would pay a premium for potatoes thus sorted; and to learn what effect the availability of potatoes separated as to mealiness by the specific gravity process would have on sales.

This research project was conducted during the fall and winter of 1951-1952 on a large Central New York farm and in 6 large super market food stores of the Loblaw's Inc. chain in Syracuse, New York.

On the Central New York farm the experimental lots of potatoes were put through a specially built specific gravity machine which sorted them into "Bakers" (with specific gravity of more than 1.080) and "Boilers" (specific gravity of 1.080 or less) after which they were thoroughly washed and dried, and packed in 10-pound white double-walled bags. A third lot of unseparated but washed potatoes from the same bin was used as a check under the name "Purple Tag."

In the 6 super markets a 6-week experiment was run from November 12 to December 22, 1951. During this 6-week period, the usual supply of other non-separated potatoes was available in all stores along with special displays of the experimental potatoes. When "Bakers," "Boilers,"

and "Purple Tag" potatoes were sold at the same price per 10-pound bag during 2 weeks in each store. "Bakers" made up 18 per cent of total sales of all potatoes; "Boilers," 15; and the "Purple Tag" 15. When a 5-cent premium was charged per 10-pound bag for "Bakers" and "Boilers" but no premium for "Purple Tag" unseparated potatoes, sales of "Bakers" dropped to 15 per cent, the "Boilers" remained at 15; and the "Purple Tag" variety increased to 16 per cent. When a 10-cent premium was charged for 10-pound bag of "Bakers" and "Boilers" with no premium for the "Purple Tag" unseparated potatoes, sales of "Bakers" dropped to 13 per cent, "Boilers" to 14; and the unseparated "Purple Tag" variety increased to 17 per cent. Throughout the period, unseparated potatoes (including "Purple Tag") accounted for 67 to 73 per cent of total store sales of potatoes.

A second 6-week experiment was run in these stores from January 7 through February 16, 1952. In this experiment, an effort was made to determine what effect variations in number and kind of experimental lots would have on total sales of potatoes, including the usual complement of other non-separated potatoes. When each store had on sale "Bakers," "Boilers" and the unseparated "Purple Tag" potatoes for 2 weeks, "Bakers" amounted to 16 per cent of the total sales; "Boilers," 15; "Purple Tag," unseparated, 14 per cent, and all other unseparated potatoes 55 per cent. During a second 2 weeks, when each store offered both "Bakers" and "Boilers" but not the "Purple Tag" the unseparated potatoes, "Bakers" made up 22 per cent of total sales, "Boilers" 23 per cent, and other unseparated potatoes 55. During a third 2 weeks in each store, neither "Bakers" nor "Boilers" were offered for sale, but the unseparated "Purple Tag" check lots were. During this period, from total sales of approximately 52,000 pounds, the "Purple Tag" potatoes accounted for 37 per cent and all others 63.

On the average, for the two 6-week experimental periods, customers of these stores bought from 12 to 15 per cent "Bakers," about the same ratio of "Boilers," and the remaining 70 to 75 per cent consisted of regular potatoes, unsorted by the specific gravity method.

All potatoes including the "Bakers," "Boilers," and unseparated "Purple Tag," met the grade of U. S. No. 1, size 2¼ to 3¼ inches. "Bakers" averaged 4.8 per cent defects; "Boilers," 5.8, and the unseparated "Purple Tag" potatoes 5.6. Regular New York potatoes in 15-pound bags averaged 4.5 per cent defects and in bulk 5.9. Maine potatoes in 50-pound bags averaged 4.5 per cent defects and those in 10-pound bags 6.6. Cuts and bruises accounted for nearly three-fourths of the defects.

Of the 16 experimental runs including 5659 bushels of potatoes, 62 of each 100 pounds met the requirements of the U. S. No. 1 grade, size 2¼ to 3¼ inches. Of this total, "Bakers" and "Boilers" each averaged 21 pounds and the unseparated "Purple Tag" potatoes 20 pounds. Of the remaining 38 pounds of each 100, approximately 10 pounds were "pick-outs" (No. 2's), and 27 pounds were rejected because they were either too large or too small, and 1 pound was culls and rots.

It took just about twice as much labor to turn out a 10-pound bag of specific gravity potatoes as of the regular pack of potatoes. A 6-man crew turned out an average of 183 ten-pound bags per hour of specific gravity processed potatoes in comparison with 375 ten-pound bags of regular

potatoes, not washed or subjected to the specific gravity process.

It is estimated that costs for oil, electric power, salt, water, annual repairs, depreciation, and interest on investment of the specific gravity machine, washer, drier and bin bagger would approximate 16⅓ cents more per 100 pounds for handling specific gravity potatoes than for potatoes handled in the regular manner, and that labor would cost 7.077 additional cents per 100 pounds, assuming an annual production of 40,000 bushels. It seems obvious that growers must obtain at least the additional cost of performing such a service if any number of them are to engage in separating potatoes by the specific gravity process.

The costs of the required equipment would seem to prohibit its use by the average Northeastern potato grower. Such expenditures could probably best be justified in the case of a grower with a relatively large production for table stock purposes or where operations could be concentrated in a central packing house with a consistently large daily volume throughout the normal potato marketing period.

Marius P. Rasmussen, *et al., Professor of Marketing,* Department of Agricultural Economics, Cornell University, Ithaca, N. Y.

[1]Abstract of A.E. Mimeo 841.

WORLD'S CHAMPIONSHIP POTATO TROPHY

Through a representation made to the Canadian Horticultural Council a suitable trophy for the World's Championship Potato Exhibit is to be presented annually at the Royal Winter Fair.

(1) It has been reported that sufficient funds have been collected from potato growers, potato growers' organizations, *etc.* for the purchase of such a trophy.

(2) This trophy is to be awarded annually for the championship in seed classes and the present rules and regulations of the Royal Winter Fair are to pertain.

(3) The Committee responsible for arranging for this trophy are offering a prize of $50.00 in cash to the one making the best design for this trophy. The deadline for submissions of drawings is April 30th. (Drawings to be submittted to The Secretary, Canadian Horticultural Council, 219 Queen St., Ottawa, Ont.)

(4) The trophy is to be awarded annually by the "Potato Growers of Canada." Presentation will be made each year by a representative of a different province, with Mr. L. F. Burrows, Secretary of the Canadian Horticultural Council making the first presentation.

(5) As an additional award to the winner, the usual gold watch and banquet donated by the American Potash Institute Inc. of Hamilton, Ont. will be continued for the next two years at least.

(6) Mr. Frank Scammell, a member of the sub-committee, agreed to contact publicity sources in his province. Mr. E. K. Hampson of the Potash Institute and Mr. R. E. Goodin of the Ontario Department of Agriculture agreed to contact the following: Farmer's Advocate, La Ferme, Ottawa Farm Journal, The Grower, Country Guide and Calgary Stockman.

CALL FOR TITLES OF PAPERS

The Annual Meeting of the Potato Association of America will be held September 6-9 at Madison, Wisconsin. This annual meeting will be held under the auspices of the American Institute of Biological Sciences (AIBS) along with 18 other biological societies.

Complete programs of *all* societies will be printed in the AIBS Bulletin. In order to do this, titles of papers to be presented must be in the hands of the secretary by **June 2.**

DEADLINE FOR PAPERS

Please send titles of papers you plan to present at the annual meeting, *prior* to **June 2.** Titles received after this date will not be listed in the program printed in the AIBS Bulletin. This may seem early but please send in a title if you possibly can.

A sample form for submitting titles, authors and institutional affiliations follows:

ALDRICH, FREDERICK A., Department of Zoology,
Rutgers University, New Brunswick, N. J.
A Symbiotic Relationship Involving *Molgula manhattensis* (DeKay) and *Mya arenaria* L.
(Illustrated, 3¼ x 4). 15 mins.

Yours for another fine potato meeting such as we had at Ithaca.

Send titles to: Dr. R. W. Hougas
Department of Genetics
University of Wisconsin
Madison, Wisconsin